This key should allow you to understand why you choose the option you did (beyond just getting a question right or wrong). More instructions on how to use this key can be found here.

If you have a suggestion to make the keys better, please fill out the short survey here.

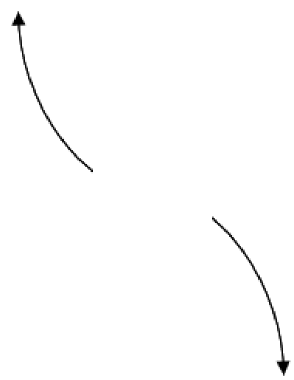
Note: This key is auto-generated and may contain issues and/or errors. The keys are reviewed after each exam to ensure grading is done accurately. If there are issues (like duplicate options), they are noted in the offline gradebook. The keys are a work-in-progress to give students as many resources to improve as possible.

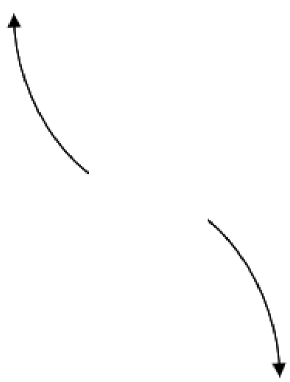
---

1. Describe the end behavior of the polynomial below.

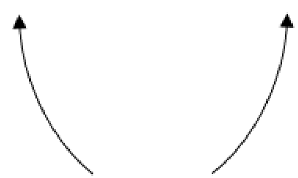
$$f(x) = -3(x+5)^4(x-5)^7(x-7)^4(x+7)^6$$

The solution is the graph below, which is option A.

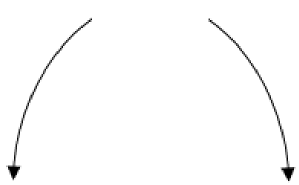




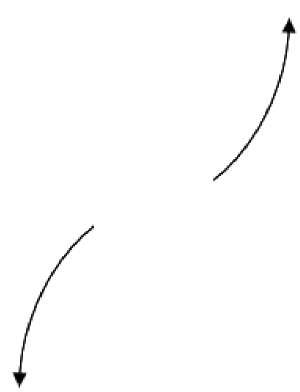
A.



C.



B.



D.

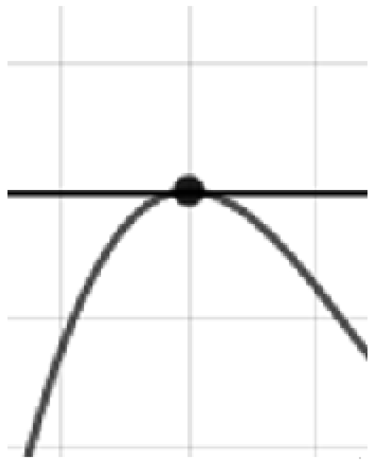
E. None of the above.

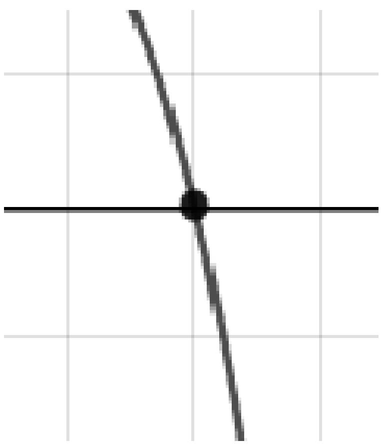
General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

2. Describe the zero behavior of the zero $x = 3$ of the polynomial below.

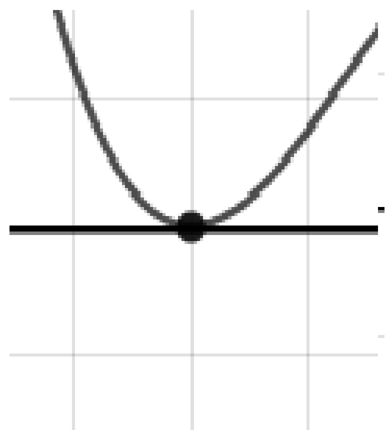
$$f(x) = 6(x-3)^8(x+3)^{13}(x-4)^9(x+4)^{12}$$

The solution is the graph below, which is option B.

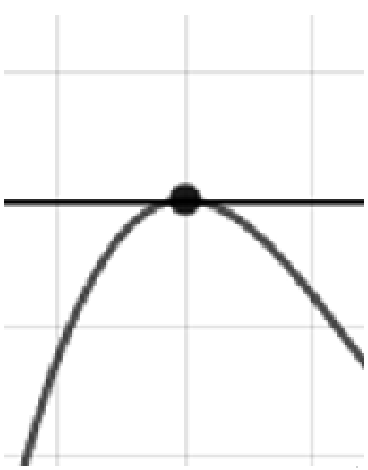




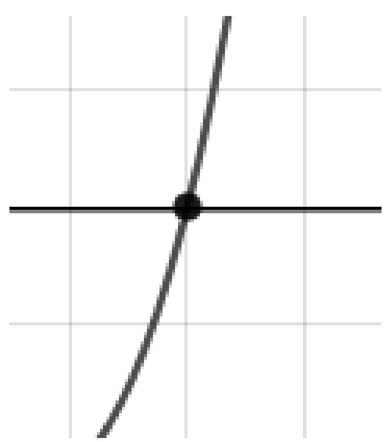
A.



C.



B.



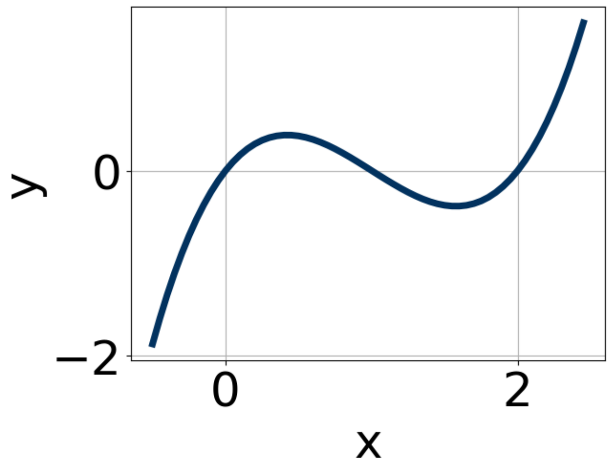
D.

E. None of the above.

General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

3. Which of the following equations *could* be of the graph presented below?



The solution is $18x^7(x-2)^7(x-1)^5$, which is option C.

A. $4x^7(x-2)^{10}(x-1)^5$

The factor 2 should have been an odd power.

B. $-8x^9(x-2)^6(x-1)^5$

The factor $(x-2)$ should have an odd power and the leading coefficient should be the opposite sign.

C. $18x^7(x-2)^7(x-1)^5$

* This is the correct option.

D. $7x^{10}(x-2)^8(x-1)^{11}$

The factors 2 and 0 have have been odd power.

E. $-12x^9(x-2)^5(x-1)^5$

This corresponds to the leading coefficient being the opposite value than it should be.

General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

4. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$4 + 5i \text{ and } 2$$

The solution is $x^3 - 10x^2 + 57x - 82$, which is option D.

A. $b \in [7, 16], c \in [56, 57.3], \text{ and } d \in [81, 86.3]$

$x^3 + 10x^2 + 57x + 82$, which corresponds to multiplying out $(x-(4+5i))(x-(4-5i))(x+2)$.

B. $b \in [0, 2], c \in [-6.8, -1.8],$ and $d \in [3.8, 8.5]$

$x^3 + x^2 - 6x + 8$, which corresponds to multiplying out $(x-4)(x-2)$.

C. $b \in [0, 2], c \in [-8.8, -6.5],$ and $d \in [8.4, 13.1]$

$x^3 + x^2 - 7x + 10$, which corresponds to multiplying out $(x-5)(x-2)$.

D. $b \in [-13, -4], c \in [56, 57.3],$ and $d \in [-84.9, -79.5]$

* $x^3 - 10x^2 + 57x - 82$, which is the correct option.

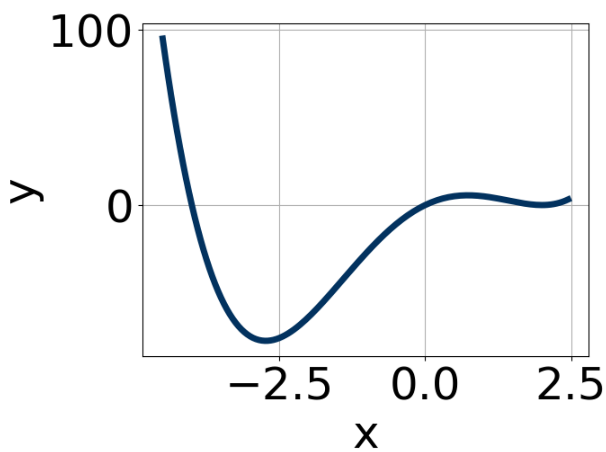
E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (4 + 5i))(x - (4 - 5i))(x - (2))$.

---

5. Which of the following equations *could* be of the graph presented below?



The solution is $11x^9(x-2)^8(x+4)^7$, which is option D.

A. $-18x^9(x-2)^{10}(x+4)^8$

The factor $(x+4)$ should have an odd power and the leading coefficient should be the opposite sign.

B. $19x^6(x-2)^9(x+4)^9$

The factor 2 should have an even power and the factor 0 should have an odd power.

C. $-14x^9(x-2)^6(x+4)^5$

This corresponds to the leading coefficient being the opposite value than it should be.

D. $11x^9(x-2)^8(x+4)^7$

* This is the correct option.

E. $19x^6(x-2)^{10}(x+4)^9$

The factor x should have an odd power.

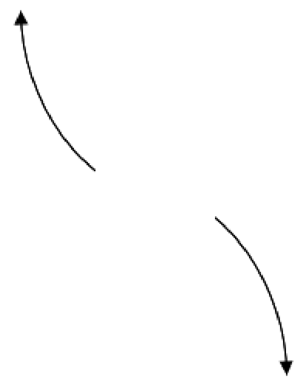
General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

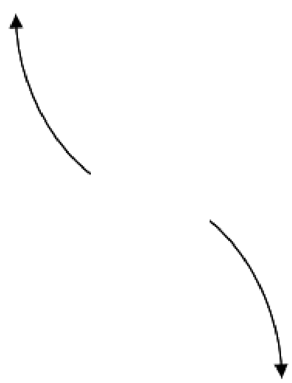
---

6. Describe the end behavior of the polynomial below.

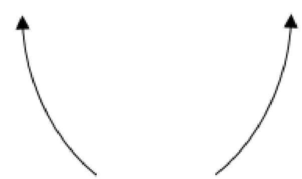
$$f(x) = -3(x+2)^3(x-2)^8(x+6)^5(x-6)^5$$

The solution is the graph below, which is option A.

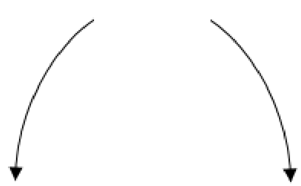




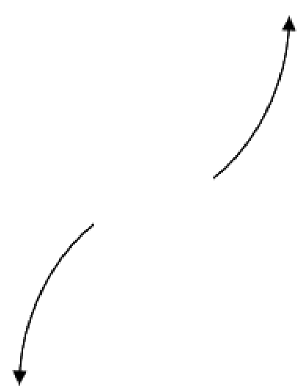
A.



C.



B.



D.

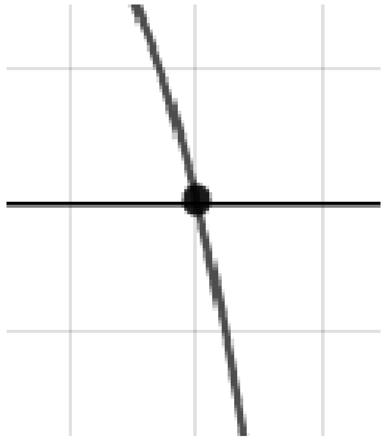
E. None of the above.

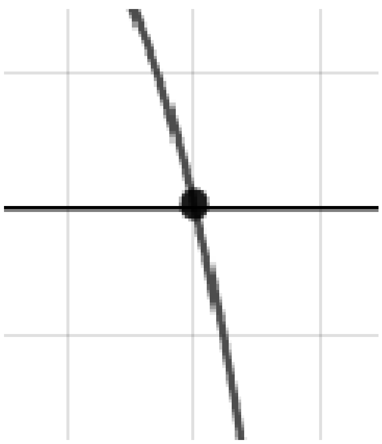
General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

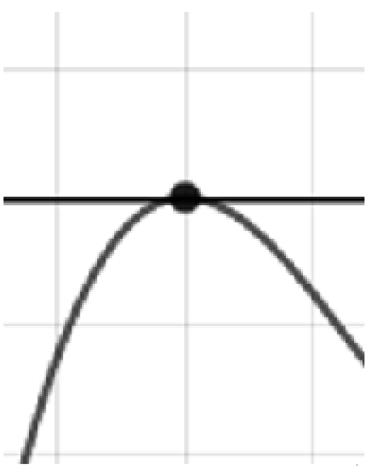
7. Describe the zero behavior of the zero $x = 7$ of the polynomial below.

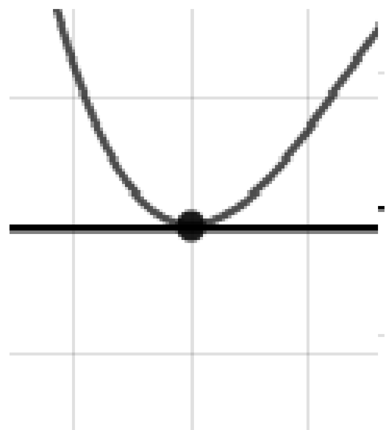
$$f(x) = 9(x+8)^9(x-8)^7(x-7)^7(x+7)^2$$

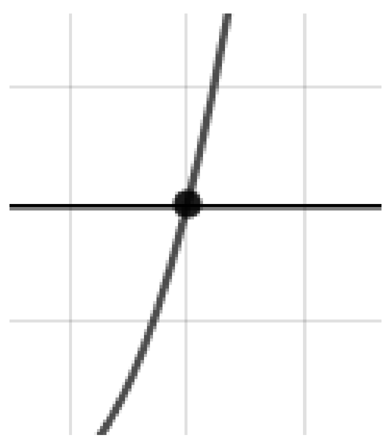
The solution is the graph below, which is option A.



A. 

B. 

C. 

D. 

E. None of the above.

General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

8. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{-1}{5}, \frac{-1}{4}, \text{ and } 6$$

The solution is $20x^3 - 111x^2 - 53x - 6$, which is option E.

A. $a \in [16, 21], b \in [107, 116], c \in [-55, -47], \text{ and } d \in [-2, 13]$

$20x^3 + 111x^2 - 53x + 6$, which corresponds to multiplying out $(5x - 1)(4x - 1)(x + 6)$.

B. $a \in [16, 21], b \in [-137, -123], c \in [51, 61], \text{ and } d \in [-9, -5]$

$20x^3 - 129x^2 + 55x - 6$, which corresponds to multiplying out $(5x - 1)(4x - 1)(x - 6)$.

C. $a \in [16, 21], b \in [-113, -106], c \in [-55, -47], \text{ and } d \in [-2, 13]$

$20x^3 - 111x^2 - 53x + 6$, which corresponds to multiplying everything correctly except the constant term.

D. $a \in [16, 21], b \in [-120, -116], c \in [-19, -4], \text{ and } d \in [-2, 13]$

$20x^3 - 119x^2 - 7x + 6$, which corresponds to multiplying out $(5x - 1)(4x + 1)(x - 6)$.

E. $a \in [16, 21], b \in [-113, -106], c \in [-55, -47], \text{ and } d \in [-9, -5]$

* $20x^3 - 111x^2 - 53x - 6$, which is the correct option.

General Comment: To construct the lowest-degree polynomial, you want to multiply out $(5x + 1)(4x + 1)(x - 6)$

---

9. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$-5 + 4i \text{ and } -2$$

The solution is $x^3 + 12x^2 + 61x + 82$, which is option D.

A. $b \in [-14, -10], c \in [53, 67], \text{ and } d \in [-88, -77]$

$x^3 - 12x^2 + 61x - 82$, which corresponds to multiplying out $(x - (-5 + 4i))(x - (-5 - 4i))(x - 2)$.

B. $b \in [1, 6], c \in [-5, -1], \text{ and } d \in [-8, 0]$

$x^3 + x^2 - 2x - 8$, which corresponds to multiplying out $(x - 4)(x + 2)$.

C. $b \in [1, 6], c \in [7, 8], \text{ and } d \in [9, 17]$

$x^3 + x^2 + 7x + 10$, which corresponds to multiplying out $(x + 5)(x + 2)$.

D. $b \in [9, 25], c \in [53, 67], \text{ and } d \in [82, 90]$

* $x^3 + 12x^2 + 61x + 82$, which is the correct option.

E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (-5 + 4i))(x - (-5 - 4i))(x - (-2))$.

---

10. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{-5}{4}, \frac{-3}{4}, \text{ and } -5$$

The solution is $16x^3 + 112x^2 + 175x + 75$, which is option E.

A. $a \in [12, 18], b \in [44, 51], c \in [-145, -143], \text{ and } d \in [73, 83]$

$16x^3 + 48x^2 - 145x + 75$, which corresponds to multiplying out $(4x - 5)(4x - 3)(x + 5)$.

B. $a \in [12, 18], b \in [104, 114], c \in [171, 181], \text{ and } d \in [-76, -74]$

$16x^3 + 112x^2 + 175x - 75$, which corresponds to multiplying everything correctly except the constant term.

C. $a \in [12, 18], b \in [72, 73], c \in [-60, -50], \text{ and } d \in [-76, -74]$

$16x^3 + 72x^2 - 55x - 75$, which corresponds to multiplying out $(4x - 5)(4x + 3)(x + 5)$.

D. $a \in [12, 18], b \in [-114, -109], c \in [171, 181], \text{ and } d \in [-76, -74]$

$16x^3 - 112x^2 + 175x - 75$, which corresponds to multiplying out $(4x - 5)(4x - 3)(x - 5)$.

E. $a \in [12, 18], b \in [104, 114], c \in [171, 181], \text{ and } d \in [73, 83]$

* $16x^3 + 112x^2 + 175x + 75$, which is the correct option.

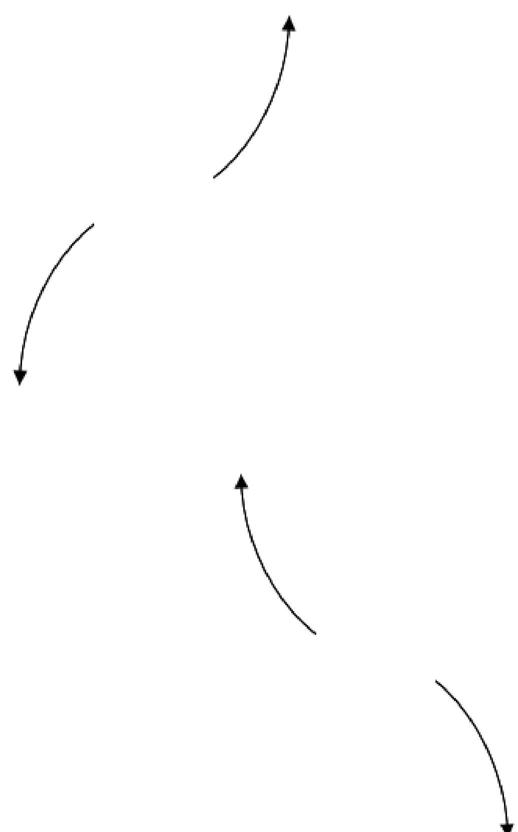
General Comment: To construct the lowest-degree polynomial, you want to multiply out $(4x + 5)(4x + 3)(x + 5)$

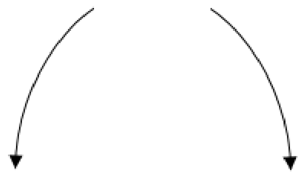
---

11. Describe the end behavior of the polynomial below.

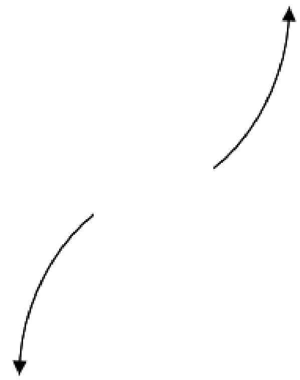
$$f(x) = 4(x + 3)^4(x - 3)^9(x + 2)^4(x - 2)^6$$

The solution is the graph below, which is option D.

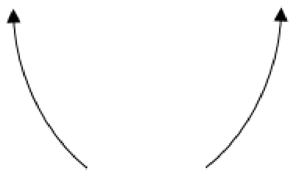




B.



D.



C.

E. None of the above.

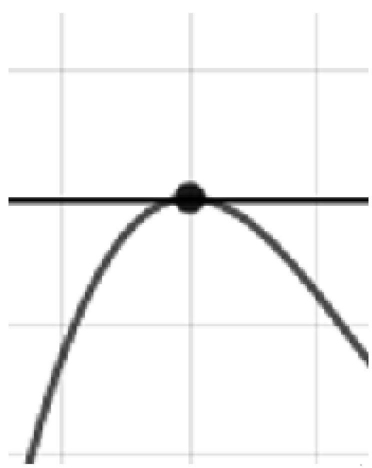
General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

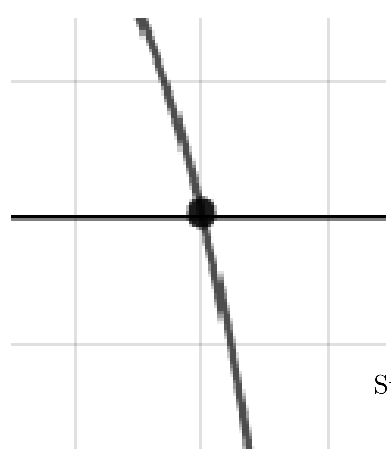
---

12. Describe the zero behavior of the zero $x = -8$ of the polynomial below.

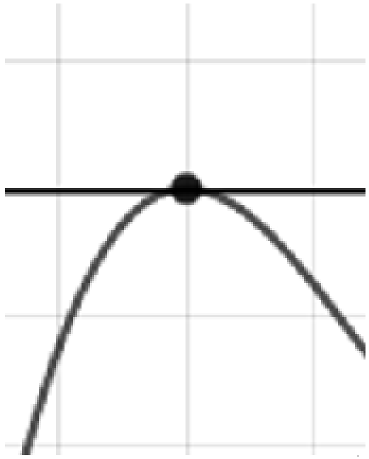
$$f(x) = -3(x+9)^6(x-9)^5(x+8)^{14}(x-8)^9$$

The solution is the graph below, which is option B.

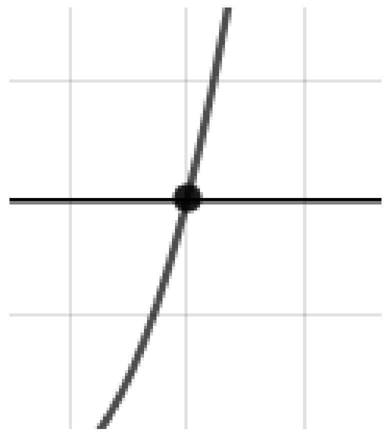




A.

B. 

C. 

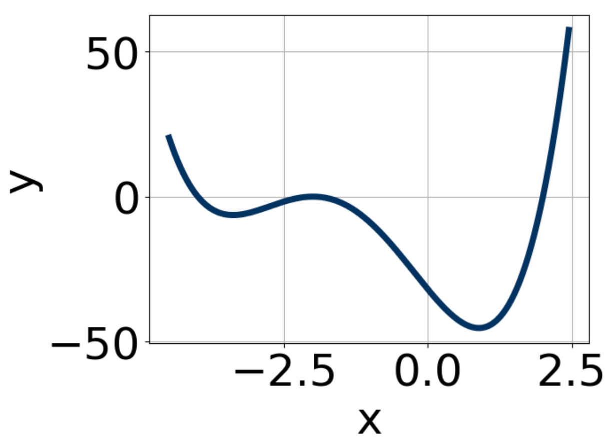
D. 

E. None of the above.

General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

13. Which of the following equations *could* be of the graph presented below?



The solution is $17(x+2)^{10}(x-2)^{7}(x+4)^{5}$, which is option A.

A. $17(x+2)^{10}(x-2)^{7}(x+4)^{5}$

* This is the correct option.

B. $-9(x+2)^{10}(x-2)^{9}(x+4)^{11}$

This corresponds to the leading coefficient being the opposite value than it should be.

C. $-18(x+2)^{10}(x-2)^{11}(x+4)^{10}$

The factor $(x+4)$ should have an odd power and the leading coefficient should be the opposite sign.

D. $8(x+2)^{7}(x-2)^{4}(x+4)^{5}$

The factor -2 should have an even power and the factor 2 should have an odd power.

E. $20(x+2)^{4}(x-2)^{4}(x+4)^{9}$

The factor $(x-2)$ should have an odd power.

General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

14. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$3 + 2i \text{ and } 4$$

The solution is $x^3 - 10x^2 + 37x - 52$, which is option C.

A. $b \in [1, 8], c \in [-7.52, -6.31], \text{ and } d \in [11, 13]$

$x^3 + x^2 - 7x + 12$, which corresponds to multiplying out $(x-3)(x-4)$.

B. $b \in [5, 14], c \in [36.76, 37.91], \text{ and } d \in [49, 57]$

$x^3 + 10x^2 + 37x + 52$, which corresponds to multiplying out $(x-(3+2i))(x-(3-2i))(x+4)$.

C. $b \in [-15, -7], c \in [36.76, 37.91], \text{ and } d \in [-52, -48]$

* $x^3 - 10x^2 + 37x - 52$, which is the correct option.

D. $b \in [1, 8], c \in [-6.57, -5.83], \text{ and } d \in [6, 9]$

$x^3 + x^2 - 6x + 8$, which corresponds to multiplying out $(x-2)(x-4)$.

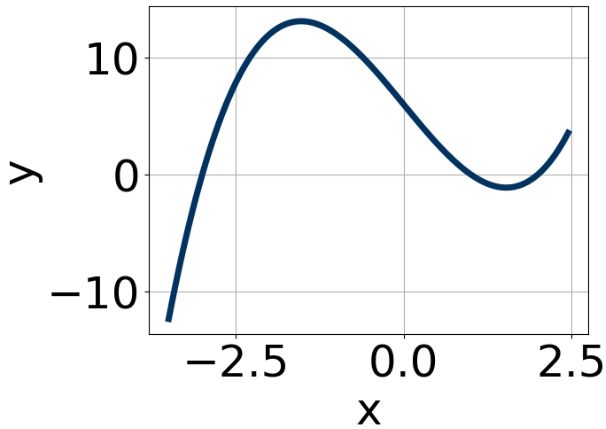
E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x-(3+2i))(x-(3-2i))(x-(4))$.

---

15. Which of the following equations *could* be of the graph presented below?



The solution is $16(x-2)^5(x+3)^5(x-1)^5$, which is option B.

A. $4(x-2)^4(x+3)^6(x-1)^5$

The factors 2 and -3 have have been odd power.

B. $16(x-2)^5(x+3)^5(x-1)^5$

* This is the correct option.

C. $-9(x-2)^{10}(x+3)^9(x-1)^7$

The factor $(x-2)$ should have an odd power and the leading coefficient should be the opposite sign.

D. $4(x-2)^6(x+3)^7(x-1)^{11}$

The factor 2 should have been an odd power.

E. $-10(x-2)^{11}(x+3)^5(x-1)^7$

This corresponds to the leading coefficient being the opposite value than it should be.

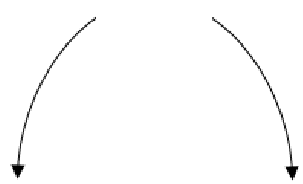
General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

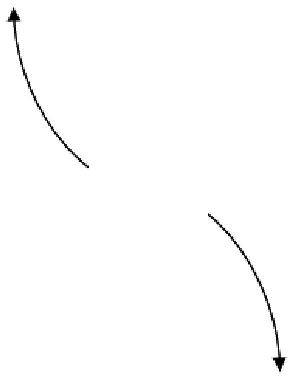
---

16. Describe the end behavior of the polynomial below.

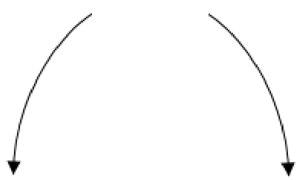
$$f(x) = -9(x+8)^4(x-8)^5(x-6)^4(x+6)^5$$

The solution is the graph below, which is option B.

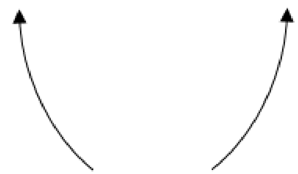




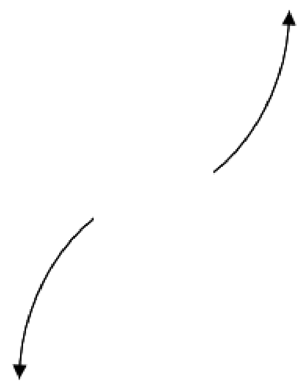
A.



B.



C.



D.

E. None of the above.

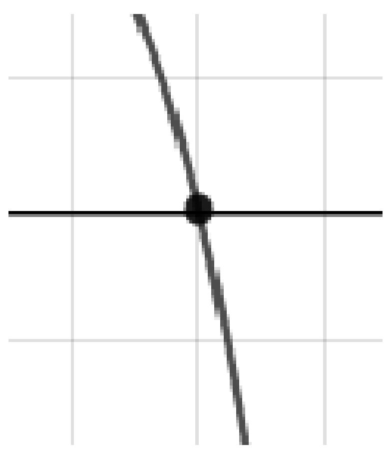
General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

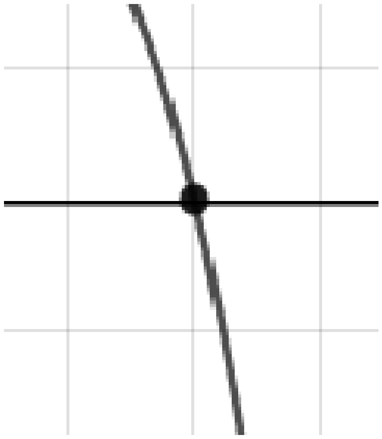
---

17. Describe the zero behavior of the zero $x = -5$ of the polynomial below.

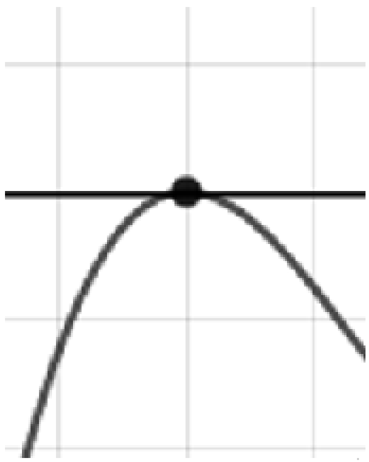
$$f(x) = -9(x-5)^4(x+5)^7(x-9)^4(x+9)^8$$

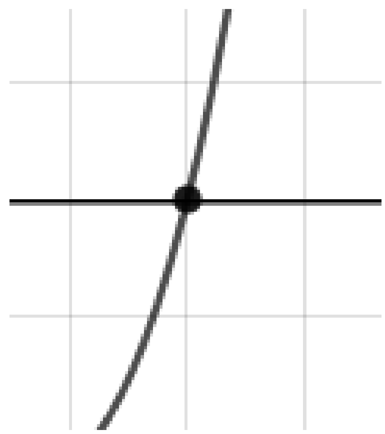
The solution is the graph below, which is option A.



A. 

C. 

B. 

D. 

E. None of the above.

General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

18. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$1, \frac{-3}{4}, \text{ and } \frac{6}{5}$$

The solution is $20x^3 - 29x^2 - 9x + 18$, which is option A.

A. $a \in [20, 21], b \in [-35, -25], c \in [-9, 1],$ and $d \in [15, 24]$

   * $20x^3 - 29x^2 - 9x + 18$, which is the correct option.

B. $a \in [20, 21], b \in [-22, -14], c \in [-21, -16],$ and $d \in [15, 24]$

   $20x^3 - 19x^2 - 21x + 18$, which corresponds to multiplying out $(x + 1)(4x - 3)(5x - 6)$.

C. $a \in [20, 21], b \in [27, 36], c \in [-9, 1],$ and $d \in [-26, -17]$

   $20x^3 + 29x^2 - 9x - 18$, which corresponds to multiplying out $(x + 1)(4x - 3)(5x + 6)$.

D. $a \in [20, 21], b \in [-35, -25], c \in [-9, 1],$ and $d \in [-26, -17]$

   $20x^3 - 29x^2 - 9x - 18$, which corresponds to multiplying everything correctly except the constant term.

E. $a \in [20, 21], b \in [10, 12], c \in [-33, -25],$ and $d \in [-26, -17]$

$20x^3 + 11x^2 - 27x - 18$, which corresponds to multiplying out $(x + 1)(4x + 3)(5x - 6)$.

General Comment: To construct the lowest-degree polynomial, you want to multiply out $(x-1)(4x+3)(5x-6)$

---

19. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$3 + 4i \text{ and } 4$$

The solution is $x^3 - 10x^2 + 49x - 100$, which is option D.

A. $b \in [-5, 7], c \in [-7.9, -4.2],$ and $d \in [11, 13]$

$x^3 + x^2 - 7x + 12$, which corresponds to multiplying out $(x - 3)(x - 4)$.

B. $b \in [-5, 7], c \in [-8.4, -7.9],$ and $d \in [13, 18]$

$x^3 + x^2 - 8x + 16$, which corresponds to multiplying out $(x - 4)(x - 4)$.

C. $b \in [7, 19], c \in [48.6, 51.5],$ and $d \in [98, 101]$

$x^3 + 10x^2 + 49x + 100$, which corresponds to multiplying out $(x - (3 + 4i))(x - (3 - 4i))(x + 4)$.

D. $b \in [-10, -4], c \in [48.6, 51.5],$ and $d \in [-102, -94]$

* $x^3 - 10x^2 + 49x - 100$, which is the correct option.

E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (3 + 4i))(x - (3 - 4i))(x - (4))$.

---

20. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{3}{4}, \frac{5}{2}, \text{ and } -4$$

The solution is $8x^3 + 6x^2 - 89x + 60$, which is option C.

A. $a \in [5, 9], b \in [16, 29], c \in [-71, -68],$ and $d \in [-63, -58]$

$8x^3 + 18x^2 - 71x - 60$, which corresponds to multiplying out $(4x + 3)(2x - 5)(x + 4)$.

B. $a \in [5, 9], b \in [-13, -5], c \in [-95, -76],$ and $d \in [-63, -58]$

$8x^3 - 6x^2 - 89x - 60$, which corresponds to multiplying out $(4x + 3)(2x + 5)(x - 4)$.

C. $a \in [5, 9], b \in [2, 9], c \in [-95, -76],$ and $d \in [55, 66]$

* $8x^3 + 6x^2 - 89x + 60$, which is the correct option.

D. $a \in [5, 9], b \in [2, 9], c \in [-95, -76],$ and $d \in [-63, -58]$

$8x^3 + 6x^2 - 89x - 60$, which corresponds to multiplying everything correctly except the constant term.

E. $a \in [5, 9], b \in [57, 64], c \in [115, 125],$ and $d \in [55, 66]$

$8x^3 + 58x^2 + 119x + 60$, which corresponds to multiplying out $(4x + 3)(2x + 5)(x + 4)$.

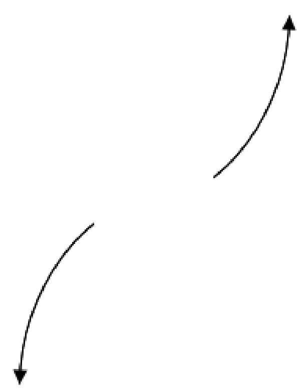
General Comment: To construct the lowest-degree polynomial, you want to multiply out $(4x - 3)(2x - 5)(x + 4)$

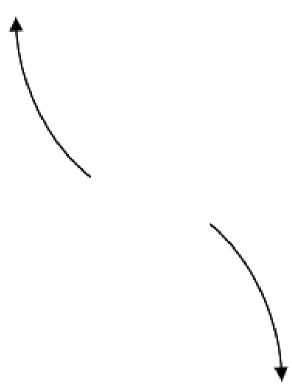
---

21. Describe the end behavior of the polynomial below.

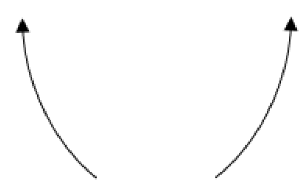
$$f(x) = 7(x + 5)^4(x - 5)^7(x - 9)^3(x + 9)^3$$

The solution is the graph below, which is option D.

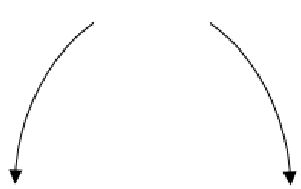




A.



C.



B.

D.

E. None of the above.

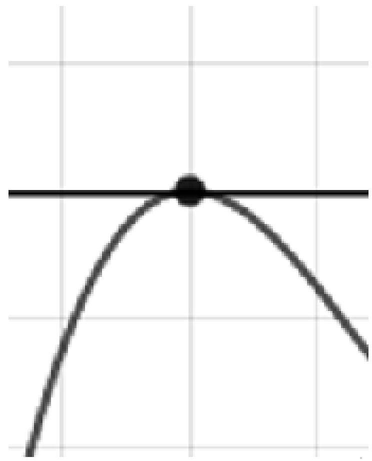
General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

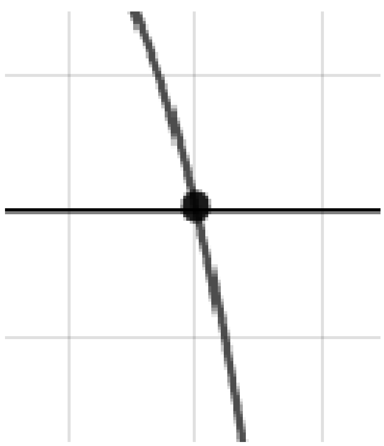
---

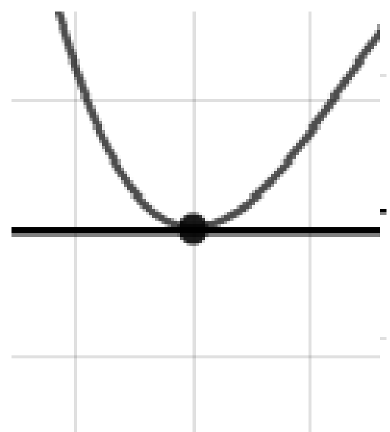
22. Describe the zero behavior of the zero $x = -5$ of the polynomial below.

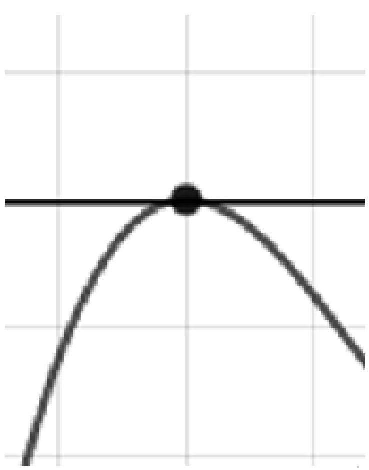
$$f(x) = 3(x-3)^9(x+3)^7(x+5)^4(x-5)^3$$

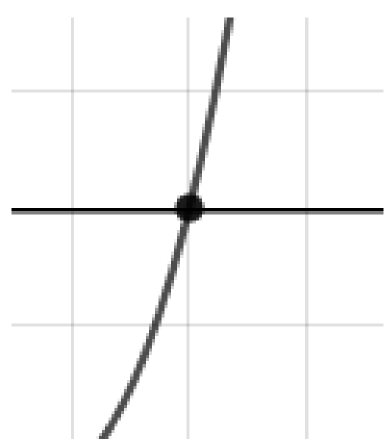
The solution is the graph below, which is option B.



A. 

C. 

B. 

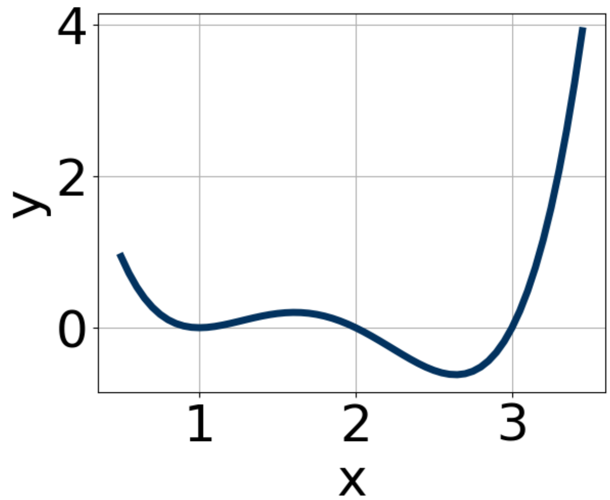
D. 

E. None of the above.

General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

23. Which of the following equations *could* be of the graph presented below?



The solution is $7(x-1)^6(x-2)^{11}(x-3)^7$, which is option D.

A. $9(x-1)^{10}(x-2)^8(x-3)^5$

The factor $(x-2)$ should have an odd power.

B. $19(x-1)^7(x-2)^{10}(x-3)^5$

The factor 1 should have an even power and the factor 2 should have an odd power.

C. $-11(x-1)^4(x-2)^{11}(x-3)^4$

The factor $(x-3)$ should have an odd power and the leading coefficient should be the opposite sign.

D. $7(x-1)^6(x-2)^{11}(x-3)^7$

* This is the correct option.

E. $-6(x-1)^{10}(x-2)^{11}(x-3)^5$

This corresponds to the leading coefficient being the opposite value than it should be.

General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

24. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form x^3+bx^2+cx+d.

$$5+2i \text{ and } 4$$

The solution is $x^3-14x^2+69x-116$, which is option D.

A. $b \in [13, 15], c \in [64, 73], \text{ and } d \in [114, 122]$

$x^3+14x^2+69x+116$, which corresponds to multiplying out $(x-(5+2i))(x-(5-2i))(x+4)$.

B. $b \in [-4, 5], c \in [-19, -7],$ and $d \in [17, 23]$

$x^3 + x^2 - 9x + 20$, which corresponds to multiplying out $(x - 5)(x - 4)$.

C. $b \in [-4, 5], c \in [-8, -3],$ and $d \in [8, 14]$

$x^3 + x^2 - 6x + 8$, which corresponds to multiplying out $(x - 2)(x - 4)$.

D. $b \in [-16, -13], c \in [64, 73],$ and $d \in [-125, -112]$

* $x^3 - 14x^2 + 69x - 116$, which is the correct option.

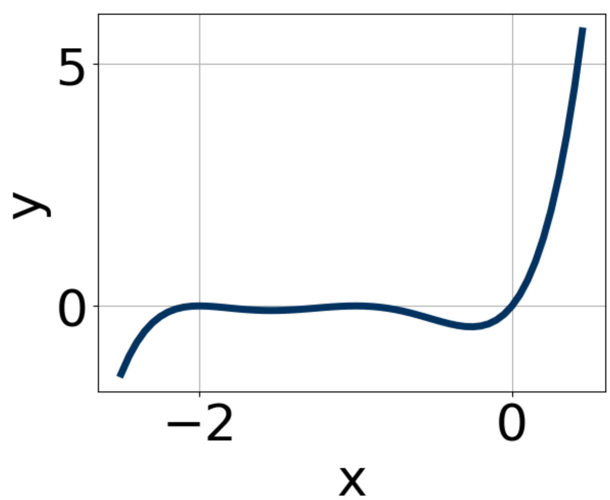
E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (5 + 2i))(x - (5 - 2i))(x - (4))$.

---

25. Which of the following equations *could* be of the graph presented below?



The solution is $2x^9(x + 1)^8(x + 2)^{10}$, which is option E.

A. $19x^5(x + 1)^6(x + 2)^7$

The factor $(x + 2)$ should have an even power.

B. $-14x^7(x + 1)^{10}(x + 2)^4$

This corresponds to the leading coefficient being the opposite value than it should be.

C. $14x^6(x + 1)^{10}(x + 2)^9$

The factor $(x + 2)$ should have an even power and the factor x should have an odd power.

D. $-11x^4(x + 1)^{10}(x + 2)^4$

The factor x should have an odd power and the leading coefficient should be the opposite sign.

E. $2x^9(x + 1)^8(x + 2)^{10}$

* This is the correct option.

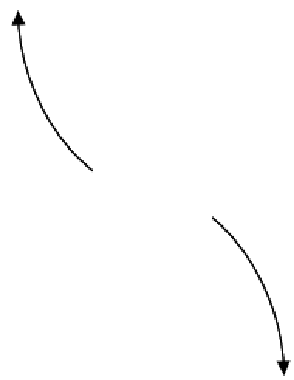
General Comment: General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

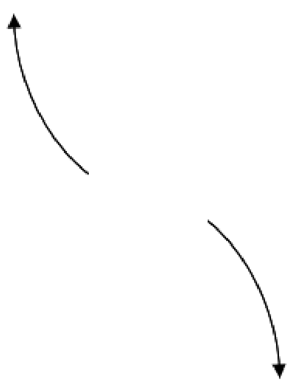
---

26. Describe the end behavior of the polynomial below.

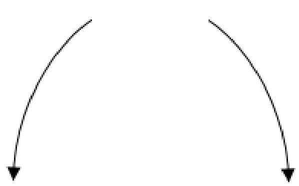
$$f(x) = -4(x-4)^3(x+4)^6(x+8)^5(x-8)^5$$

The solution is the graph below, which is option A.

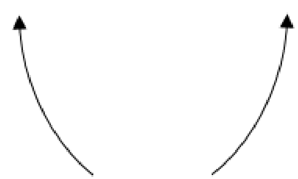




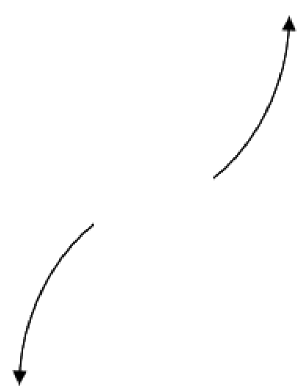
A.



B.



C.



D.

E. None of the above.

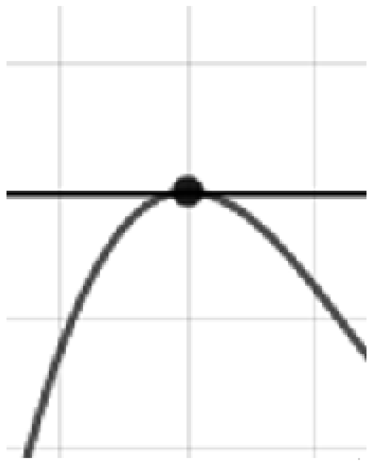
General Comment: Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

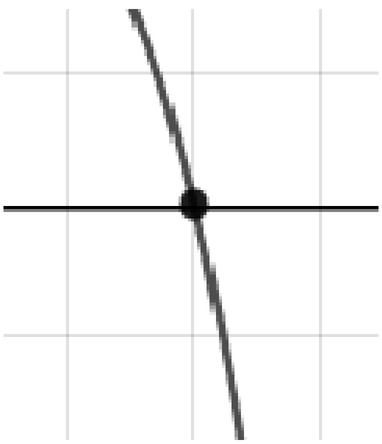
---

27. Describe the zero behavior of the zero $x = 9$ of the polynomial below.

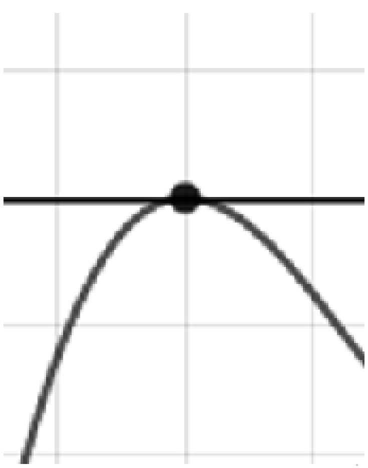
$$f(x) = -7(x-9)^4(x+9)^7(x+2)^6(x-2)^7$$

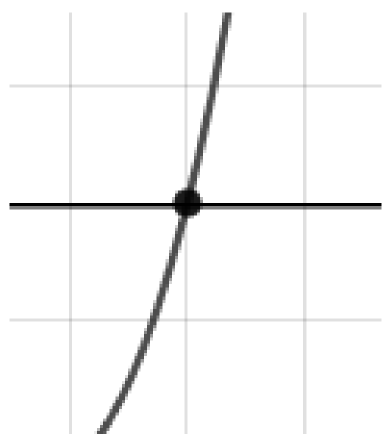
The solution is the graph below, which is option B.



A. 

C. 

B. 

D. 

E. None of the above.

General Comment: You will need to sketch the entire graph, then zoom in on the zero the question asks about.

28. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{1}{4}, 4, \text{ and } \frac{3}{5}$$

The solution is $20x^3 - 97x^2 + 71x - 12$, which is option A.

A. $a \in [12, 21], b \in [-101, -93], c \in [61, 75]$, and $d \in [-15, -8]$

* $20x^3 - 97x^2 + 71x - 12$, which is the correct option.

B. $a \in [12, 21], b \in [-101, -93], c \in [61, 75]$, and $d \in [8, 15]$

$20x^3 - 97x^2 + 71x + 12$, which corresponds to multiplying everything correctly except the constant term.

C. $a \in [12, 21], b \in [-88, -82], c \in [23, 26]$, and $d \in [8, 15]$

$20x^3 - 87x^2 + 25x + 12$, which corresponds to multiplying out $(4x + 1)(x - 4)(5x - 3)$.

D. $a \in [12, 21], b \in [95, 101], c \in [61, 75]$, and $d \in [8, 15]$

$20x^3 + 97x^2 + 71x + 12$, which corresponds to multiplying out $(4x + 1)(x + 4)(5x + 3)$.

E. $a \in [12, 21], b \in [69, 77], c \in [-36, -28]$, and $d \in [-15, -8]$

$20x^3 + 73x^2 - 31x - 12$, which corresponds to multiplying out $(4x + 1)(x + 4)(5x - 3)$.

General Comment: To construct the lowest-degree polynomial, you want to multiply out $(4x - 1)(x - 4)(5x - 3)$

29. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$-3 + 2i \text{ and } 1$$

The solution is $x^3 + 5x^2 + 7x - 13$, which is option B.

A. $b \in [-8, -3], c \in [7, 8]$, and $d \in [11, 14]$

$x^3 - 5x^2 + 7x + 13$, which corresponds to multiplying out $(x - (-3 + 2i))(x - (-3 - 2i))(x + 1)$.

B. $b \in [2, 8], c \in [7, 8]$, and $d \in [-16, -8]$

* $x^3 + 5x^2 + 7x - 13$, which is the correct option.

C. $b \in [1, 2], c \in [0, 4]$, and $d \in [-5, -2]$

$x^3 + x^2 + 2x - 3$, which corresponds to multiplying out $(x + 3)(x - 1)$.

D. $b \in [1, 2], c \in [-7, 1]$, and $d \in [0, 5]$

$x^3 + x^2 - 3x + 2$, which corresponds to multiplying out $(x - 2)(x - 1)$.

E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

General Comment: Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (-3 + 2i))(x - (-3 - 2i))(x - (1))$.

30. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$4, \frac{-3}{5}, \text{ and } \frac{3}{4}$$

The solution is $20x^3 - 83x^2 + 3x + 36$, which is option C.

A. $a \in [19, 26], b \in [81, 88], c \in [3, 6], \text{ and } d \in [-37, -33]$

$20x^3 + 83x^2 + 3x - 36$, which corresponds to multiplying out $(x + 4)(5x - 3)(4x + 3)$.

B. $a \in [19, 26], b \in [76, 78], c \in [-22, -18], \text{ and } d \in [-37, -33]$

$20x^3 + 77x^2 - 21x - 36$, which corresponds to multiplying out $(x + 4)(5x + 3)(4x - 3)$.

C. $a \in [19, 26], b \in [-85, -80], c \in [3, 6], \text{ and } d \in [29, 39]$

* $20x^3 - 83x^2 + 3x + 36$, which is the correct option.

D. $a \in [19, 26], b \in [46, 63], c \in [-101, -94], \text{ and } d \in [29, 39]$

$20x^3 + 53x^2 - 99x + 36$, which corresponds to multiplying out $(x + 4)(5x - 3)(4x - 3)$.

E. $a \in [19, 26], b \in [-85, -80], c \in [3, 6], \text{ and } d \in [-37, -33]$

$20x^3 - 83x^2 + 3x - 36$, which corresponds to multiplying everything correctly except the constant term.

General Comment: To construct the lowest-degree polynomial, you want to multiply out $(x - 4)(5x + 3)(4x - 3)$